Unit 1

# Conservation of Forages



## Introduction

Feed alone constitute about 70 per cent of the total animal production cost. Fodder crops are the essential and cheapest source of feed for ruminants. Therefore, feeding strategies aimed at improving milk production in cows and buffaloes can be based on the selection of fodder crops, which is important to reduce the cost of animal production. Land availability for the cultivation of fodder crops is decreasing day-by-day. As a result, there is tremendous pressure of livestock on the available feed and fodder. Intensive fodder production and judicious use of fodder support animal productivity. To excel in dairy farming, an entrepreneur needs to pay attention to fodder cultivation and conservation of forages.

*Fig. 1.1: Fodder crop (napier grass) at Indian Veterinary Research Institute (IVRI), Izatnagar*

## Session 1: Fodder Crops and their Harvesting

Fodder include crops and pasture species that are grown, harvested and processed to be used as feed for farm animals. Fodder is either directly

fed to the animals or preserved for future use as feed. Fodder crops are plants that are grown to yield high biomass. These are rich in nutrients. Feeding fodder crops keeps an animal healthy and adds to its productivity. Natural pasture is forage but is not grown as a crop.

The Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, is a premier institute for forage resource development in Asia. The Institute has developed several technologies for maximising fodder yield and fodder seed production in different agro-climatic conditions, and under various crop rotations. Fodder production technologies have been developed to meet the requirement of feed for dairy animals, especially, during lean periods. The IGFRI has developed and popularised various post–harvest technologies and machines for fodder cultivation.

## Fodder crops on the basis of season

In India, agricultural crop production seasons are divided into *Kharif*, *Rabi* and *Zaid*. Fig. 1.2 illustrates the major fodder crops cultivated during these seasons.

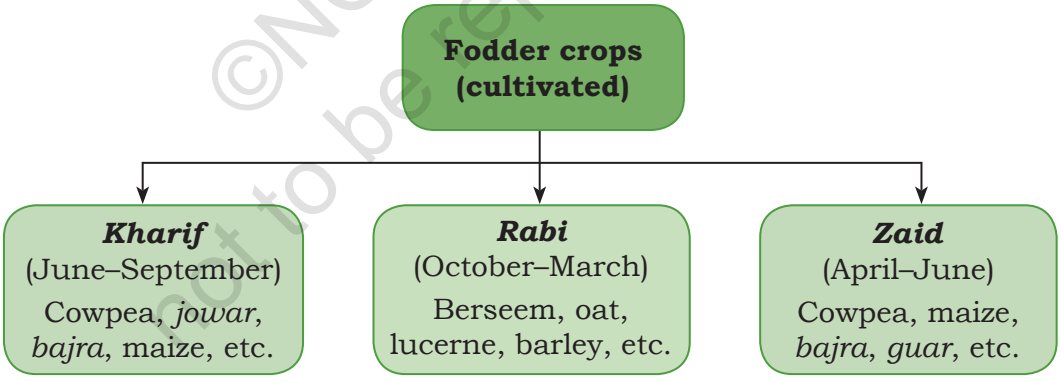


*Fig. 1.2: Classification of fodder crops on the basis of seasons*

## Fodder crops on the basis of protein content

Fodder crops are broadly divided into leguminous (containing high protein content) and non-leguminous (containing average protein content) as shown in Fig. 1.3. Fresh common leguminous fodder crops like berseem, lucerne and cowpea contain an average protein content

of 2–2.5 per cent, whereas, fresh non-leguminous fodder crops like maize, *jowar*, *bajra*, oat, etc., contain an average protein content of 0.7–1.5 per cent.

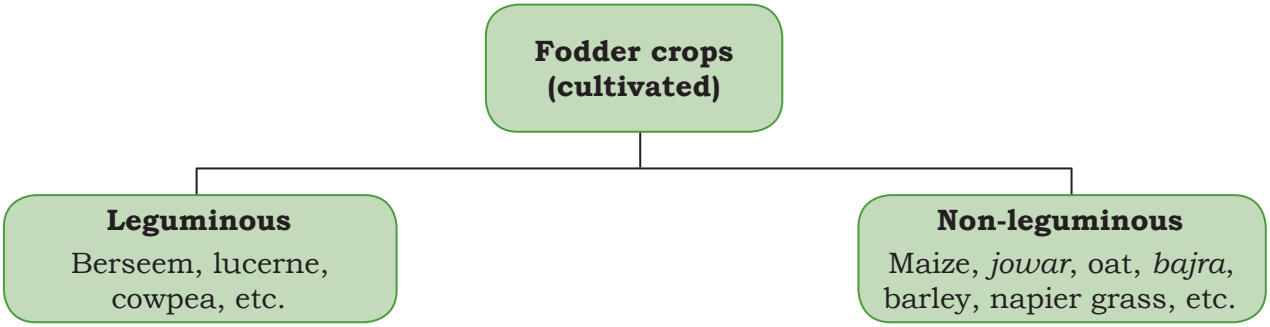


*Fig. 1.3: Classification of fodder crops on the basis of protein content*

## Common fodder crops grown in India

To grow different type of fodder crops on a farm, a dairy farmer takes into account per hectare yield of the various fodder crops being grown there. Table 1.1 shows a combination of various leguminous and non-leguminous fodder crops that may be grown by the dairy farmer.

**Table 1.1: Common leguminous and non-leguminous fodder crops grown in India in different seasons**

| Season | Fodder crops | Yield (quintal/ hectare) |
|---|---|---|
| *Kharif* | Non-leguminous | |
| | Maize *(Zea mays)* | 350–450 |
| | Sorghum *(Sorghum bicolar)* | 650–1050 |
| | Hybrid napier *(Pennisetum perpureum)* | 1200–1500 |
| | Leguminous | |
| | Cowpea *(Vigna sinensis)* | 300–350 |
| *Rabi* | Non-leguminous | |
| | Oat *(Avana sativa)* | 400–450 |
| | Barley *(Hordeum vulgare)* | 400–450 |
| | Leguminous | |
| | Berseem (*Trifolium alexandrinum*) | 750–800 |
| | Lucerne *(Medicago sativa)* | 800–1000 |

| | | |
|---|---|---|
| *Zaid* | Non-leguminous | |
| | Maize *(Zea mays)* | 350–450 |
| | Sorghum *(Sorghum bicolar)* | 650–1050 |
| | Hybrid napier *(Pennisetum perpureum)* | 1200–1500 |
| | Para grass *(Brachiaria multica)* | 750 |
| | Leguminous | |
| | Cowpea *(Vigna sinensis)* | 300–350 |
| | Lucerne *(Medicago sativa)* | 800–1000 |

*(a) Sorghum or Jowar*

*(b) Maize*

*(c) Oat*

*(d) Berseem*

*(e) Para grass*

*(f) Guinea grass*

*Fig. 1.4(a–f): Some common fodder crops grown in India*

## Harvesting of fodder crops

It means cutting and removing fodder crops from a field. Fodder crops are harvested at a particular stage of growth to optimise quantity and quality of green biomass. Harvesting fodder crops at a young stage may result in higher protein content but decreased biomass yield. On the other hand, as a plant matures, the protein content rapidly decreases. Especially at the beginning of a fodder plant's flowering stage, the protein content in the leaves and stems is drastically reduced but the total biomass yield increases. Some forage crops like sorghum are not harvested at an early stage because of the presence of anti-nutritional factors, such as *dhurrin* (a cyanogenic glycoside in plants).

### Purpose of harvesting

Forages are fed to farm animals as pasture in green chopped form, silage or hay. If the animals are allowed to graze on pasture lands, most of the forage growing in that area will be trampled, contaminated with dung and urine, and hence, wasted. Chopped green fodder is similar to intensive grazing as far as bio-availability of nutrients to animals is concerned. Though harvesting and green chopping of fodder crops involve additional costs (equipment, energy and labour costs), there are definite savings in the form of reduced wastage of fodder as there is no trampling in the pastures by the animals. Besides, the animals can be fed with tree leaves as green fodder during times of scarcity. Therefore, leaves can also be harvested and stored. Chopped green fodder ready to be fed to the animals is shown in Fig. 1.5.

*Fig. 1.5: Chopped green fodder for animals*

Loss of biomass and nutrients caused during hay and silage making occurs during harvesting and

storage stage. Harvest and storage losses are the highest in silage and haymaking. However, these losses can be minimised if hay and silage making practices are followed strategically. Harvesting serves the following purposes.

- Provides green fodder to the animals
- Provides optimum nutrients to the animals
- Facilitates increased biomass yield from a field
- Stores excess fodder in the form of hay, silage, etc., for use during lean period
- Maintains desired plant species in pasture

## Methods of harvesting

Harvesting is, usually, carried out by either of the following methods.

***Manual***

Sickle is the most common tool used for harvesting fodder crops. It must be sharp, curved and serrated. Other traditionally designed tools are also used for harvesting and cutting of crops or tougher portions of plants in different parts of the country.

***Mechanical***

In this method, harvesting is done with the use of implements or machines, such as tractor attached fodder cutter.

## Harvesting time

All fodder crops change in nutritive profile as they mature. Fodder crops at very early stages of growth have high protein content and are, usually, easily digestible but their yield (total volume or biomass) is low. As a plant grows, the yield increases but digestibility and protein content decrease. The stage of harvesting determines the herbage yield and quality in all fodder crops. A balance between yield and quality, therefore, needs to be assessed for harvesting of crops. The harvesting time of major fodder crops is shown in Table 1.2.



**Table 1.2: Harvesting time of major fodder crops**

| Fodder crop | Growth stage and time of harvesting |
|---|---|
| *Jowar* | Single-cut varieties: Harvesting is done immediately after flowering to 50 per cent flowering stage of a plant.<br>Multi-cut varieties: The first cutting must be done when the plant is two months old and subsequent cuts at an interval of 35–40 days. |
| Maize | The usual harvesting time is 60–70 days after sowing when plants are in the 'milk stage'. At this stage, the seed head is green and the developing grain contains milky starch.<br>As green fodder: Harvesting must start at the 'cob formation stage' and be completed before the milk stage.<br>For silage preparation: Harvesting must be done when the cobs are soft or glazed with high energy content. |
| *Bajra* | The usual harvesting time is the 'boot leaf stage' or immediately after flowering in case of few plants.<br>In case of multi-cut varieties, subsequent cuttings can be made at an interval of 30–40 days. |
| Oat | When oat is cultivated as a single crop, harvesting must be done at the initiation of flowering to 50 per cent bloom stage. However, in mixed cropping, both the crops need to be cultivated jointly once they attain maturity. The first cutting must be made 60–70 days after sowing. |
| Cowpea | Single-cut varieties: Harvesting must be done 70–90 days after sowing.<br>Double-cut varieties: The first cut needs to be made 50–55 days after sowing or when the crop has grown 15 cm above the ground level. The second cut is made 45–50 days after the first cutting.<br>Three-cut varieties: The first cut must be made 45–50 days after sowing and subsequent two cuttings after every 25–30 days. |
| Berseem | The first cut must be made at 45–50 days of sowing, while the subsequent cuts be made at an interval of 20–25 days. In all, four to five cuttings may be obtained. |
| Lucerne | The first cut is made 45–60 days after sowing. Subsequent cuts are made at an interval of 20–30 days. The crop can be retained for three to four years in the same field. |





| | |
|---|---|
| Hybrid napier grass | The first cut is made 9–10 weeks after planting. Subsequent cuts are made after four to six weeks or when the plant attains a height of 1.5 metre. Annually, at least six to eight cuts need to be made. |
| Para grass | The first harvest takes about three months after planting when the grass attains a height of about 60–75 cm. Subsequent cuts are made at an interval of 30–40 days. |

## Practical Exercise

**Activity**

Prepare a herbarium sheet of seasonal fodder crops and write their nutritive value in terms of protein content.

**Material required:** herbarium sheet, leaves of different fodder crops, double-sided tape or glue and writing material

**Procedure**

- Collect leaves of different seasonal fodder crops from the school campus and surrounding areas.
- Paste four to five different leaves on a single herbarium sheet, label them and mention their protein percentage.
- Discuss it in class.



## Check Your Progress

**A. Multiple Choice Questions**

1. The Indian Grassland and Fodder Research Institute is located in _____.
   (a) New Delhi (b) Kolkata
   (c) Jhansi (d) Bareilly
2. _____ is a *Kharif* fodder.
   (a) Berseem (b) Maize
   (c) Barley (d) Oat
3. _____ is considered as a *Rabi* fodder.
   (a) Berseem (b) Maize
   (c) Cowpea (d) Sorghum
4. _____ is a leguminous fodder.
   (a) Sorghum (b) Mustard
   (c) Lucerne (d) Maize
5. Which of these purposes does harvesting of fodder serve?
   (a) Provides optimum nutrients to animals
   (b) Facilitates increased biomass yield from a field
   (c) Provides green fodder to animals
   (d) All of the above

**B. Fill in the Blanks**

1. The scientific name of sorghum is _____.
2. Sorghum must not be harvested at an early stage because of the presence of anti-nutritional factors like _____.
3. The usual harvesting time for maize is _____ days after sowing when the plants are in the milk stage.
4. The scientific name of lucerne is _____.
5. _____ is a leguminous fodder grown in the *Kharif* season.

**C. Mark 'True' or 'False'**

1. Fodder crops are the essential and cheapest source of feed for ruminants.
2. Leguminous fodder crops contain high protein content.
3. As a plant grows, biomass yield increases.
4. Year-round fodder production facilitates storage of fodder.
5. As a plant matures, its protein content decreases rapidly.

**D. Match the Columns**

| A | B |
|---|---|
| 1. Berseem | (a) *Vigna sinensis* |
| 2. Lucerne | (b) *Sorghum bicolar* |
| 3. Cowpea | (c) *Hordeum vulgare* |
| 4. Sorghum | (d) *Trifolium alexandrinum* |
| 5. Barley | (e) *Medicago sativa* |

**E. Crossword**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | [1]R | | [2]B | | | |
| | | [3]K | H | | | I | F |
| | [4]B | A | | R | | | |
| | | | | | | | |
| [5]C | | W | | | A | | |
| | | | | Y | | | |
| | T | | | | | | |

**Across**

1. Fodder crop is cultivated in winter season.
3. Fodder crop is cultivated in rainy season.
4. Scientific name of the fodder is *Pennisetum typhoides*.
5. Leguminous fodder crop in *Kharif* season.

**Down**

2. Non-legumiuous fodder grown in the *Rabi* season.





## SESSION 2: METHODS OF CONSERVATION OF FORAGES AND ASSESSING THEIR QUALITY

### Conservation of forages

Fodder is the primary feed for all ruminants (cow, buffalo, sheep, goat, etc.). But it is not regularly and sufficiently available through the year. In India, during the rainy season, plenty of greens are available but they are not effectively utilised by farmers due to lack of knowledge about fodder conservation. The surplus fodder can be conserved in the form of hay and silage during periods of excess availability. By adopting hay and silage making techniques, quality fodder can be availed during lean periods (May to July and October to November) as well. The conserved fodder can be used either for consumption at a dairy farm or sold to farmers. During natural calamities like flood, draught, etc., this fodder serves as feed for farm animals, including dairy animals, providing them with the required nutrients.

#### Conditions for forage conservation

The various conditions required for the conservation of forages are depicted in Fig. 1.6.



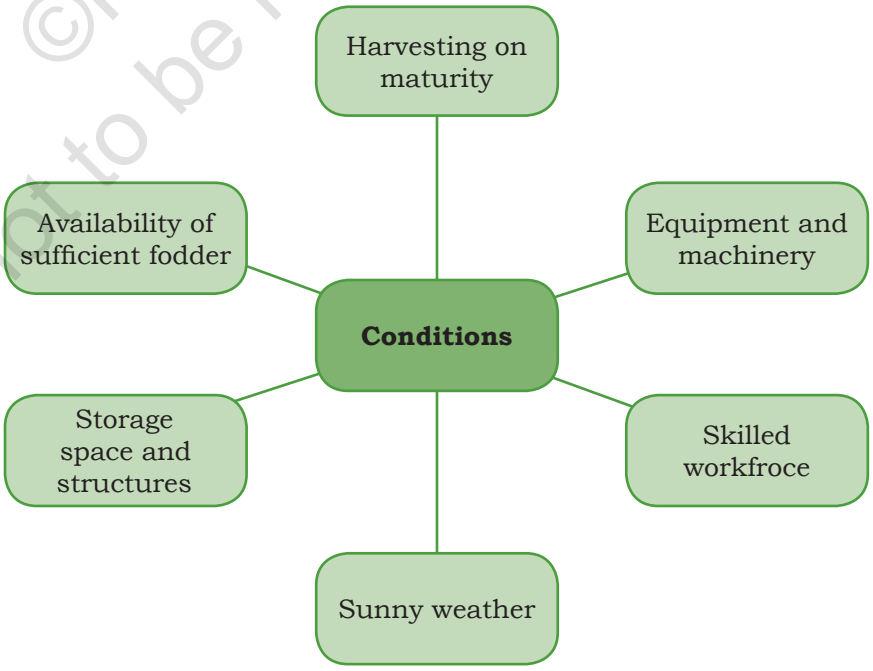


*Fig. 1.6: Conditions required for forage conservation*

## Tools and equipment for forage conservation

The various tools and equipment required for conservation of forages are given in Table 1.3. These tools and equipment must meet the necessary occupational health and safety standards.

**Table 1.3: Tools and equipment required for forage conservation, and their functions**

| Tools and equipment | Functions |
|---|---|
| Mower | It is a machine used to cut fodder crops and leave them in a swath (a row of cut crops during single passage of a mowing machine). |
| Sickle | It is a tool used in manual harvesting of fodder crops. It consists of a metallic blade (plain or serrated) and a wooden handle. |
| Wooden or metal forks | This tool is required for turning, tedding, loading and stacking fodder. |
| Tractor with trolley | It is a machine used in transportation of fodder. |
| Chaff cutter | It is a tool used to chaff fodder into small pieces. Both manually and electrically operated chaff cutters are available in market. |
| Baler | It is a machine used to compress and compact hay into bales. The baler is attached to a tractor. |
| Electrically operated chaff cutter | It is a machine used in uniform chopping of fodder for livestock. Chaff cutters available in market are equipped with electric motor, pulley and belt. |

*(a) Mower*

*(b) Sickle*

*(c) Tractor with trolley*

*(d) Electrically operated chaff cutter*

*(e) Different type of electrically operated chaff cutter*

*Fig. 1.7 (a–e): Tools and equipment used for forage conservation*

## Methods of forage conservation

Some of the commonly practised forage conservation methods are as follows.

### *Hay*

Hay is obtained when forage crops are preserved by reducing their moisture content from about 85 to 15–20 per cent. Fodder crops with hollow stems are most suitable for haymaking. The process of haymaking turns green and perishable forage into a product that can be safely stored and easily transported without getting spoilt. The nutritive value of forage determines the nutritional profile of hay. The maintenance requirement for dairy animals can be met solely by feeding quality hay to them. Maintenance, here, implies maintaining the health and growth of the animals.

*Steps for haymaking*

Mowing or cutting: The fodder must be harvested at the stage of maturity, which is a major factor in determining the quality of hay. But herbage quality drops rapidly with increasing maturity, especially, after flowering. Therefore, young leafy grass is less easy to handle than mature herbage. However, the yield of the former is less. A compromise between yield and quality has to be made, and usually, cutting at early to mid-flowering stage will give a reasonable product.

Curing: This is the process of drying the fodder to reach the appropriate moisture content of about 15–20 per cent. Curing starts in the field after cutting, when the material is left to wilt. The 'wilting period' varies with the type of material and weather conditions. The various methods of drying practised in haymaking are as follows.

(a) Artificial conditioning: It refers to rapid drying of fodder crops with machines and fans.

(b) Turning and tedding: It allows uniform drying of swath, helps dissipate heat, and reduces the danger of mould development and fermentation.

(c) Windrowing: It refers to the process of putting the cut herbage in rows for further handling and collection, and for protection at night. In hot arid conditions, windrowing protects the crop against shattering and bleaching.

(d) Trussing: It includes making small heaps during intermediate stages of drying and is largely practised in manual systems of forage conservation.

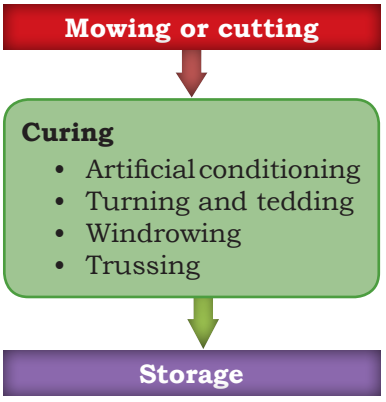


*Fig. 1.8: Steps involved in haymaking*

Storage: Hay can be kept for long periods, if it contains moisture up to 15–20 per cent. Hay is, generally, stored loose, baled or chopped.

### *Silage*

Silage is obtained by fermentation of forages under anaerobic conditions. The process of conserving green fodder in this way is known as 'ensiling'. The container, in which the material is fermented, is called a 'silo'. The structure of a bunker-type silo is shown in Fig. 1.9(a). Silage is also called 'pickled grass'. Silage is wet forage with about 70 per cent moisture content. Fodder crops having thick stems are suitable for silage making. The steps involved in silage making are shown in Fig. 1.10.



*Fig. 1.9(a): Structure of bunker-type silo*

*Fig. 1.9(b): Silage pit*

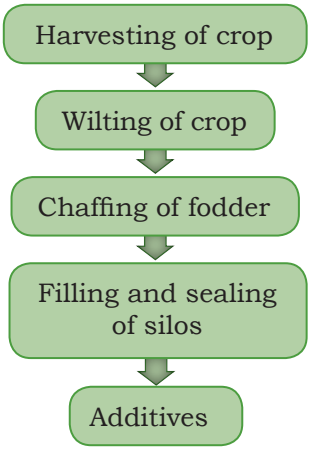


*Fig. 1.10: Steps involved in silage making*

*Steps for silage making*

Harvesting of crop: A fodder crop must be harvested when its stems are thick and they have about 70 per cent moisture content.

Wilting of crop: The green fodder must have about 30 per cent dry content. This is achieved by allowing wilting for a certain period.

Chaffing of fodder: The fodder must be chaffed into small pieces, preferably 2–3 cm, either with the help of a manually operated chaff cutter or power-driven chaff cutter.

Filling and sealing of silos: The silos must be filled within 3–4 days and the material must be compacted to prevent the entry of outside air. Preventing the entry of outside air is called 'sealing', which must be for a minimum of 60–70 days, after which the silage is ready to be used as animal feed.

Additives: Depending upon the type of fodder crop, additives like urea, mollases, etc., can be added to the chaffed fodder to improve the nutrient value of the silage.

***Straw and agricultural waste***

After harvesting the grain crops, the remaining plant parts can be used as dry fodder for animals. Straws and other agriculture waste are preserved for a long duration without much effort. Straws can be easily stored in hay or straw godown and fed to the animals (Fig. 1.11).

*Fig. 1.11: Godown for storing straw (bhusa)*

## Assessing the quality of conserved forage

***Hay***

The quality of hay is judged on the basis of the following characteristics.

- If the hay is yellow or green in colour, it is of good quality.
- If the hay is yellow or grey in colour, it is of average quality.

- If the colour is brown or black, then the hay is of poor quality.
- The hay must be checked for the presence of mould, dust and foul smell.
- It must also be checked for the presence of weeds, thorns, etc.

***Silage***

Silage quality is, usually, judged on the basis of the following characteristics.

- Smell (Butyric acid)
- Colour (quality silage is greenish yellow in colour)
- Wetness and structure
- Soil contamination

## Ways to minimise environmental impact

Forage debris can attract vermin and cause losses to the stored hay. Therefore, safe and appropriate disposal of waste and debris generated from feed storage is essential to minimise harmful environmental impacts. The following points must be considered to minimise harmful effects to the environment.

- Surroundings around the storage structure must be cleaned regularly.
- The stored feed material must be checked regularly to avoid spoilage.
- Chemicals must not be used for artificial curing of hay as they may have a harmful impact on the environment.
- Routine cleaning and servicing of machinery and equipment must be carried out in accordance with the manufacturer's specifications.
- Effluents are generated from conserved forage structures, such as silos. Therefore, suitable arrangements for run-offs must be made in an effluent treatment plant.





## Assessing the requirement of conserved fodder

The total amount of fodder (in tons) required for a particular farm depends on a number of factors. Some of the factors that influence the fodder requirement of a dairy farm are shown in Fig. 1.12.

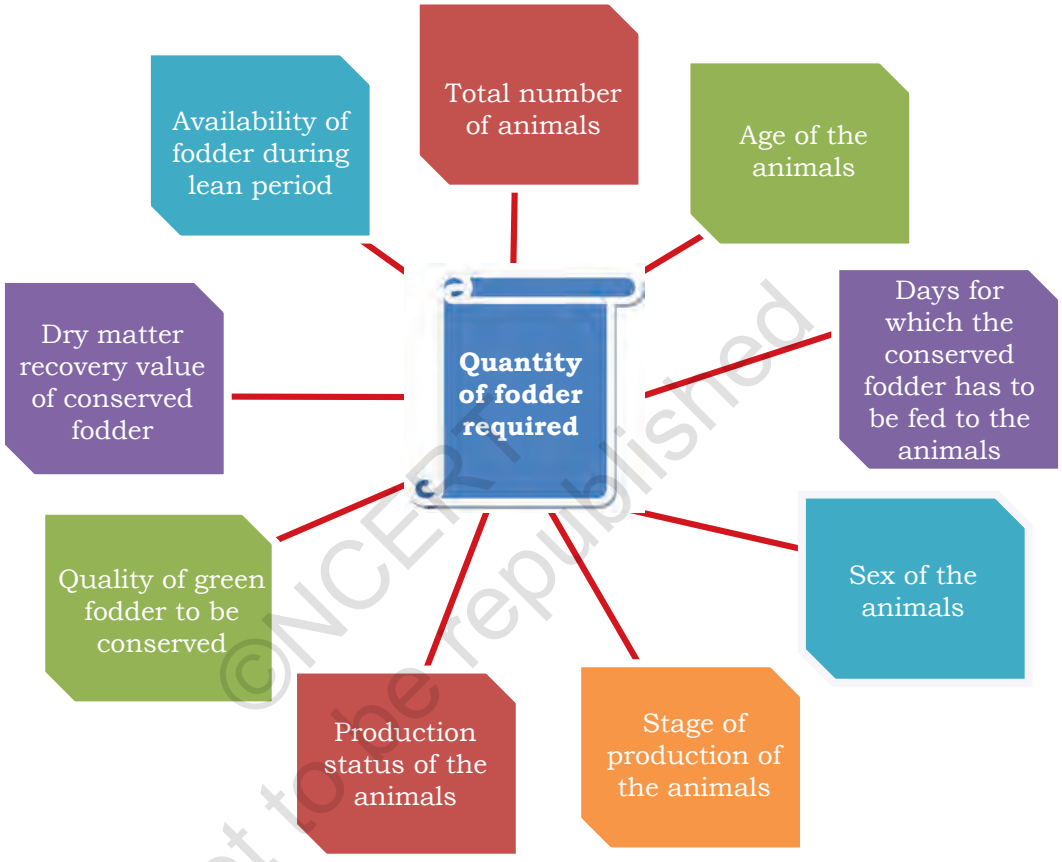


*Fig. 1.12: Factors influencing fodder requirement in a dairy farm*

As a thumb rule, a cow can consume 20–25 kg of silage per day. For a unit of 10 cows, approximately 240 quintal of silage is required during fodder scarcity period, i.e., four months (10 animals × 20 kg per day × 120 days = 240 quintal). Similarly, adult animals consume about 5–6 kg hay per day, besides other feeds. For a unit of 10 cows, approximately 72 quintal of hay is required during the fodder scarcity period, i.e., four months (10 animals × 6 kg per day × 120 days = 72 quintal).

## Practical Exercise

**Activity**

Demonstrate the process of haymaking.

**Material required:** sickle, wood or metal fork, tractor and writing material

**Procedure**

- Mowing or cutting: Harvest the fodder to be used for haymaking.
- Curing: Dry the fodder to attain appropriate moisture content at about 15 to 20 per cent.
- Storage: Hay must be stored loose, baled or chopped.

## Check Your Progress

**A. Multiple Choice Questions**

1. Dry matter content of silage must preferably be _____ per cent.
   (a) 10 (b) 15
   (c) 20 (d) 30
2. Fodder is not the primary feed for which animal?
   (a) Cow (b) Buffalo
   (c) Pig (d) Goat
3. _____ is also known as 'pickled grass'.
   (a) Hay (b) Silage
   (c) Dry fodder (d) None of the above
4. The smell of good quality silage is due to the presence of _____.
   (a) Butyric acid (b) Acetic acid
   (c) Propionic acid (d) None of the above
5. _____ is not, generally, required for conservation of forages.
   (a) Sickle (b) Baler
   (c) Chaff cutter (d) Rotavator

**B. Fill in the Blanks**

1. _____ stem crops are suitable for haymaking.
2. Dry matter content of stored hay preferably needs to be about _____ per cent.
3. After _____ days of sealing of silo, silage will be ready to feed animals.
4. Good quality silage is _____ in colour.
5. Good quality hay is _____ or in colour.





**C. Mark 'True' or 'False'**

1. Hollow stem crops are suitable for silage making.
2. Silage is prepared under aerobic conditions.
3. A baler is used to prepare hay.
4. Fire hazard is a problem of silage.
5. Brown or black colour hay indicates it is of poor quality.

**D. Match the Columns**

| A | B |
|---|---|
| 1. Mower | (a) For turning, tedding, loading and stacking of fodder |
| 2. Wooden or metal forks | (b) Transportation of fodder |
| 3. Tractor | (c) To compress and compact hay into bales |
| 4. Baler | (d) To chaff fodder into small pieces |
| 5. Chaff cutter | (e) To cut fodder and leave them in a swath |

**E. Crossword**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | [1]B | A | L | E | |
| | [2]C | U | R | | N | G |
| | | T | | | | |
| | | Y | | | | |
| | [3]G | | E | | N | |
| | | I | | | | |
| [4]S | I | | | L | E | |

**Across**

1. Hay can be stored in this form.
2. This is the process of drying fodder up to appropriate moisture content of about 15 to 20 per cent for haymaking.
3. This is the colour of good quality silage.
4. It is a simple harvesting tool used manually and consists of metallic blade (plain or serrated) and a wooden handle.

**Down**

1. Smell of good quality silage is due to this acid.